

Volume measures for non-market education output

Jeremy Fouliard¹ Mats Le Floch² Pauline Mendras²

¹Insee, DCN ²Insee, DEE

July 2026

Context

→ In accordance with the ESA (2010), the National Accounts Department (INSEE) currently uses an **output method** to estimate the volume of non-market education:

- Uses a **non-monetary variable**, related to the service, as a volume indicator (number of students)
- Volume $\approx$ number of students, with each education level aggregated by weighting them according to their expenditure per student

Context

→ In accordance with the ESA (2010), the National Accounts Department (INSEE) currently uses an **output method** to estimate the volume of non-market education:

- Uses a **non-monetary variable**, related to the service, as a volume indicator (number of students)
- Volume $\approx$ number of students, with each education level aggregated by weighting them according to their expenditure per student

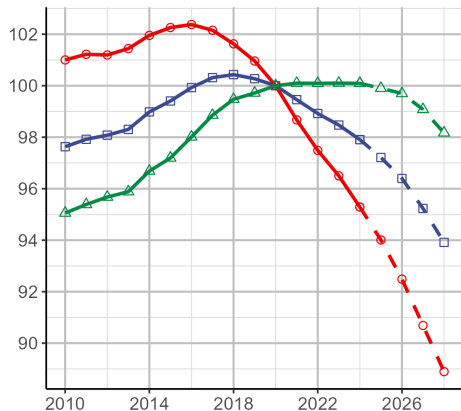
Two main challenges:

- The volume indicator mainly reflects **demographic changes**
- The volume indicator does not account for changes in the **quality** of education provided

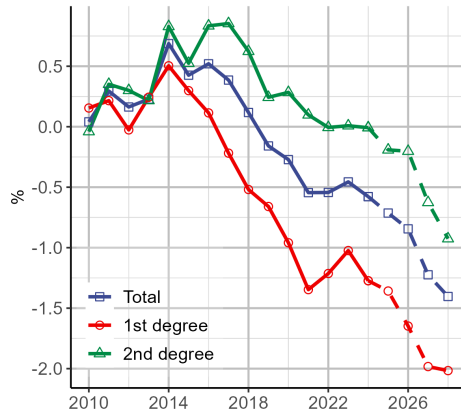
Motivation

Figure: Forecasts of education output volume for first and second degree education

Chained volume (2020 = 100)



Volume growth



Objectives

- Reports from national statistical institutes and academic studies explore various approaches to quality adjustments for non-market services (Fraumeni, 2008; Scheyer, 2010; Statcan, 2012; ONS, 2025)

Objectives

- Reports from national statistical institutes and academic studies explore various approaches to quality adjustments for non-market services (Fraumeni, 2008; Scheyer, 2010; Statcan, 2012; ONS, 2025)
- Objectives:
 - **Compare the different methods** for estimating the volume of education
 - **Test different quality adjustments within an economically interpretable theoretical framework based on the concept of human capital**

Objectives

- Reports from national statistical institutes and academic studies explore various approaches to quality adjustments for non-market services (Fraumeni, 2008; Scheyer, 2010; Statcan, 2012; ONS, 2025)
- Objectives:
 - **Compare the different methods** for estimating the volume of education
 - **Test different quality adjustments within an economically interpretable theoretical framework based on the concept of human capital**
- Quality is fundamentally a multidimensional and abstract concept, which can be proxied by :
 - **Input characteristics**: level of teacher experience
 - **Service characteristics**: class size
 - **Outcomes** of the service: PISA test scores, school climate.
- DCN and DEPP data, higher education **not included**
- **Quality adjustment prohibited by EU conventions (ESA)** for comparability reasons: exploratory work

Outline

1. Theoretical Framework

2. Tested Methods

- 2.1 Implicit quality adjustment
- 2.2 Explicit quality adjustment
- 2.3 Conclusion

From Value to Volume: The Non-Market Challenge

Non-market services (education, health...) are valued at cost in national accounts:

$$\text{Value}^t = C^t(y^t, w^t) = \sum_i X_i(y_i^t, w^t) \cdot w^t$$

Three approaches to measure *volume*:

Input measure

$$Q_{\text{input}}^t = \frac{C^t}{P_{\text{input}}^t}$$

Simple, but productivity is constant by construction

Eurostat: category C

Output measure

$$Q_{\text{output}}^t = \frac{\sum_i y_i^t c_i^{t-1}}{\sum_i y_i^{t-1} c_i^{t-1}}$$

Quantity y_i weighted by lagged unit costs

Eurostat: recommended

Outcome measure

$$H = H(y, \Omega)$$

Captures consumer welfare, but affected by external factors $\Omega \Rightarrow$ prohibited

Quality Adjustment: Conceptual Foundations

Problem: quantity y_i (e.g. pupil-hours) may miss quality attributes

Implicit quality adjustment

Stratify products into homogeneous groups i .

Quality $\approx$ cost difference across strata

Limit: cannot capture cost-neutral quality changes (e.g. teaching practices).

Explicit quality adjustment (*this paper*)

Introduce indicator q_i directly in the index:

$$v_i(y_i, q_i) = y_i f_i(q_i)$$

Challenge: how to calibrate f_i ?

Requires a theoretical foundation.

Key choice

What reduction in class size exactly offsets a 1% fall in enrolment in terms of volume?

$\Rightarrow$ Pinned down by the **elasticity** of f_i .

Calibrating Quality Weights via Outcome Elasticity

Framework: utility $U = U(H)$, outcome $H = H(y, q, \Omega)$.

Volume measure $v_i = y_i f_i(q_i)$ should replicate the substitutability between y and q in terms of outcome:

$$\underbrace{\frac{f'_i(q_i) q_i}{f_i(q_i)}}_{\text{elasticity of } f_i} = \alpha = \underbrace{\frac{\partial H / \partial q_i}{\partial H / \partial y_i} \frac{q_i}{y_i}}_{\text{outcome substitution elasticity}}$$

Application to education — outcome = human capital $H^t = y^t W^t(q^t, \Omega)$:

$$\alpha = \frac{\partial W}{\partial q_i} \frac{q_i}{W} \implies \text{elasticity of } \textit{future wages} \text{ to quality indicator } q_i$$

Calibrating Quality Weights via Outcome Elasticity

First-order quality contribution:

$$\text{contrib}_{\text{quality},i}^t \approx \frac{C_i^{t-1}}{C^{t-1}} \times \alpha \times \frac{\Delta q_i^t}{q_i^{t-1}}$$

cost share $\times$ wage elasticity $\times$ quality growth

Common functional forms for f

Form	$f(q)$
Constant elasticity	q^α
Linear	$1 + \gamma q$
Semi-elasticity	$e^{\gamma q}$

Quality Indicators: Completeness vs. Robustness

Quality-adjusted output index:

$$Q_{\text{adj}}^t = \sum_i \frac{C_i^{t-1}}{C^{t-1}} \frac{y_i^t f_i(q_i^t)}{y_i^{t-1} f_i(q_i^{t-1})}$$

Two desirable properties of a quality indicator $q = g(X, \Omega)$:

Completeness

Share of outcome variation explained by q :

$$\frac{\partial H}{\partial q} \frac{\Delta q}{\Delta H} \text{ large}$$

Example: standardized test scores have large effects on future wages.

Robustness

q should not be driven by external factors Ω :

$$\frac{\partial q}{\partial \Omega} d\Omega \ll dq$$

Example: class size is fully controlled by the school system.

If indicators are independent, adjustment functions can be **combined multiplicatively**.

Outline

1. Theoretical Framework

2. Tested Methods

- 2.1 Implicit quality adjustment
- 2.2 Explicit quality adjustment
- 2.3 Conclusion

Implicit quality adjustment (1)

Context: rapid growth in disability inclusion

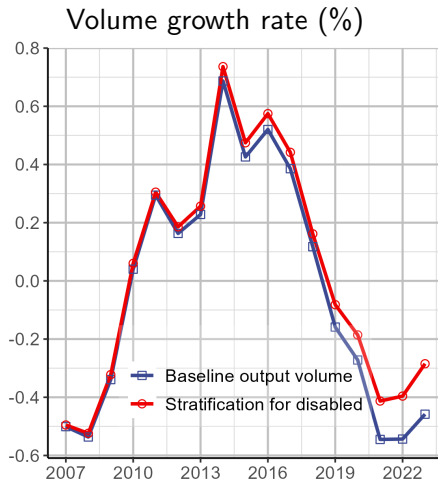
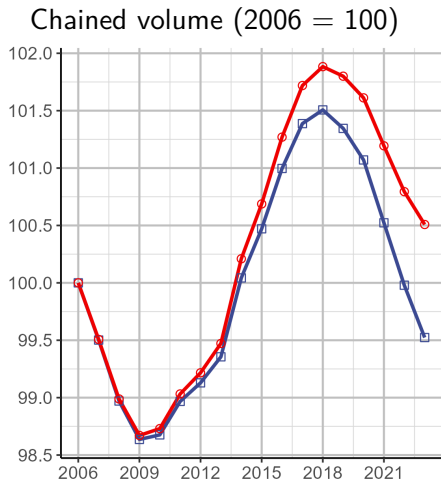
- 2005 law tripled enrolment: 151k → **496k** pupils (2024)
- Cost per disabled pupil: **+22%** above average in 2006, **+74%** in 2026
- Most new pupils integrated into **regular classes** — not a separate stratum

Solution: finer stratification

- Split each education level into **disabled** / **non-disabled** sub-strata
- Reallocate headcounts & costs using budget data (Programme 230, action 3)
- Compliant with Eurostat conventions

Implicit quality adjustment (2)

Figure: Volume of education (first and second degree)



Explicit quality adjustment with PISA scores (1)

- We model the quality-adjusted volume of education as $v(y_i^t, q_i^t) = y_i^t e^{\gamma q_i^t}$ where y_i^t denotes the number of students, q_i^t is a measure of students' performance, and $\gamma \geq 0$ is a parameter;

Explicit quality adjustment with PISA scores (1)

- We model the quality-adjusted volume of education as $v(y_i^t, q_i^t) = y_i^t e^{\gamma q_i^t}$ where y_i^t denotes the number of students, q_i^t is a measure of students' performance, and $\gamma \geq 0$ is a parameter;
- We get the following decomposition :

Explicit quality adjustment with PISA scores (1)

- We model the quality-adjusted volume of education as $v(y_i^t, q_i^t) = y_i^t e^{\gamma q_i^t}$ where y_i^t denotes the number of students, q_i^t is a measure of students' performance, and $\gamma \geq 0$ is a parameter;
- We get the following decomposition :

weight of adjusted strata ($\approx 28\%$ of total cost)

× change in q ($\approx \pm 2$ points/year $\approx \pm 0.02$ standard deviations)

× semi-elasticity (9.5% wage gain per standard deviation)

$\approx \pm 0.05$ percentage points

Explicit quality adjustment with PISA scores (1)

- We model the quality-adjusted volume of education as $v(y_i^t, q_i^t) = y_i^t e^{\gamma q_i^t}$ where y_i^t denotes the number of students, q_i^t is a measure of students' performance, and $\gamma \geq 0$ is a parameter;
- We get the following decomposition :

weight of adjusted strata ($\approx 28\%$ of total cost)

× change in q ($\approx \pm 2$ points/year $\approx \pm 0.02$ standard deviations)

× semi-elasticity (9.5% wage gain per standard deviation)

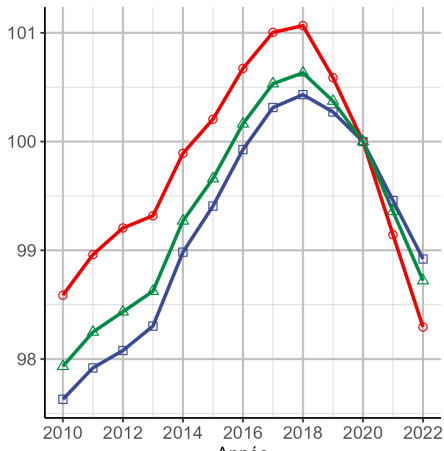
$\approx \pm 0.05$ percentage points

- Earlier levels are also adjusted with a **cohort allocation model**;

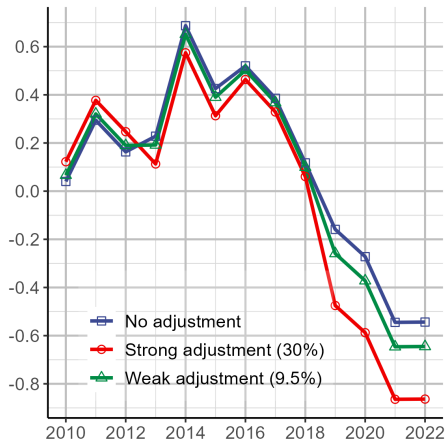
Explicit quality adjustment with PISA scores (2)

Figure: Volume of education production with a quality adjustment for PISA scores

Chained volume (2020 = 100)



Volume growth rate (%)



Explicit Quality Adjustment with Class Size (1)

Trends in France (2016–2024)

- Pre-primary: **−10%** average class size
- Primary: **−12%** — driven by declining birth rates and priority education policies (REP/REP+)
- Secondary: **stable** across all grade levels

What the literature says

Level	Finding
Primary	Consistent positive effect: +1.5 to +3% s.d. per pupil fewer (Krueger, Piketty, Fredriksson)
Primary (heterog.)	Effect twice larger for disadvantaged pupils; saturation for large classes
Lower secondary	Small positive effect, roughly half that of primary
Long run	Mixed; no robust effect on wages

Explicit Quality Adjustment with Class Size (2)

Framework: Fully-Taught Pupils (FTP)

$$FTP(q) = q \cdot f(q)$$

- $f(q)$: share of fully-taught pupils at class size q
- No adjustment: $f(q) = 1 \Rightarrow FTP = q$
- FTP assumed **concave** (saturation effect)

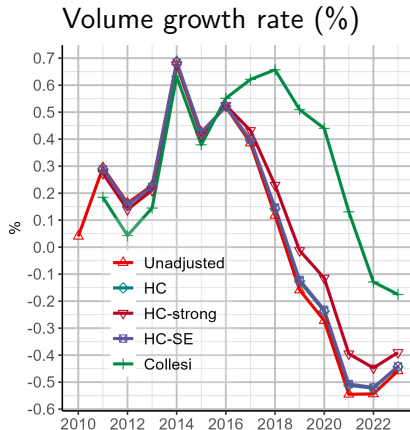
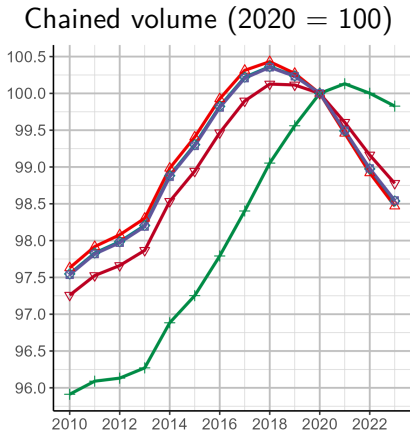
Baseline: $f^{HC}(q) = q^{-0.04}$, calibrated on Fredriksson et al.).

The effect on the annual volume growth rate is approximately:

$$\underbrace{\text{weight of adj. levels}}_{\approx 40\%} \times \underbrace{\Delta q}_{\approx \pm 1\%/yr} \times \underbrace{\text{wage elasticity}}_{0.04} = \pm 0.02 \text{ ppts}$$

Explicit Quality Adjustment with Class Size (3)

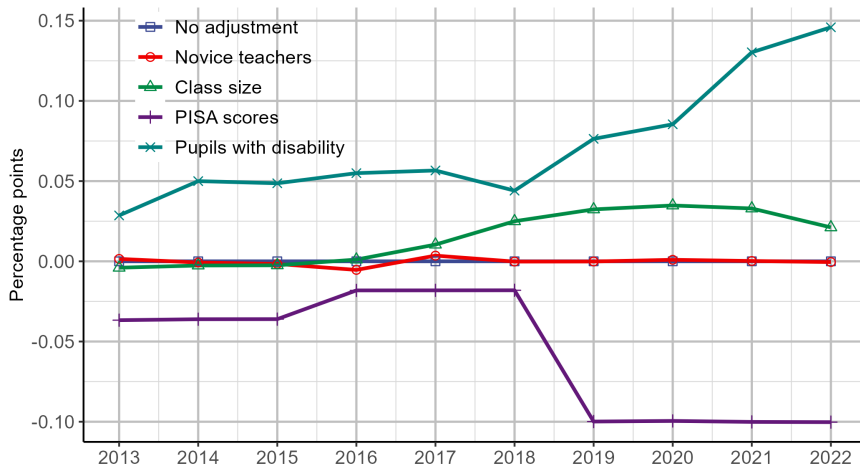
Figure: Volume of education production quality-adjusted for class size



Coverage: First and second degree education.

Summary of tested quality adjustments

Figure: Difference between the growth rates of adjusted and unadjusted volume



Conclusion

- Integrating quality adjustments within an economically interpretable theoretical framework based on the concept of human capital leads to ..

Conclusion

- Integrating quality adjustments within an economically interpretable theoretical framework based on the concept of human capital leads to ..
 - modest changes (-0.056 point per year on average for PISA, +0.016 point per year on average for class size) : due to the size of elasticities (0.04 for class size) and the proportion of adjusted strata;

Conclusion

- Integrating quality adjustments within an economically interpretable theoretical framework based on the concept of human capital leads to ..
 - modest changes (-0.056 point per year on average for PISA, +0.016 point per year on average for class size) : due to the size of elasticities (0.04 for class size) and the proportion of adjusted strata;
 - which can lead to **non-negligible cumulative changes** : the implicit quality adjustment for pupils with disability that increases the total growth of education volume by one percentage point between 2006 and 2023, from -0.5% to 0.5%

Conclusion

- Integrating quality adjustments within an economically interpretable theoretical framework based on the concept of human capital leads to ..
 - modest changes (-0.056 point per year on average for PISA, +0.016 point per year on average for class size) : due to the size of elasticities (0.04 for class size) and the proportion of adjusted strata;
 - which can lead to **non-negligible cumulative changes** : the implicit quality adjustment for pupils with disability that increases the total growth of education volume by one percentage point between 2006 and 2023, from -0.5% to 0.5%
- Pending questions ..
 - Better calibration of elasticities ?

Conclusion

- Integrating quality adjustments within an economically interpretable theoretical framework based on the concept of human capital leads to ..
 - modest changes (-0.056 point per year on average for PISA, +0.016 point per year on average for class size) : due to the size of elasticities (0.04 for class size) and the proportion of adjusted strata;
 - which can lead to **non-negligible cumulative changes** : the implicit quality adjustment for pupils with disability that increases the total growth of education volume by one percentage point between 2006 and 2023, from -0.5% to 0.5%
- Pending questions ..
 - Better calibration of elasticities ?
 - Other outcome measures ?

Conclusion

- Integrating quality adjustments within an economically interpretable theoretical framework based on the concept of human capital leads to ..
 - modest changes (-0.056 point per year on average for PISA, +0.016 point per year on average for class size) : due to the size of elasticities (0.04 for class size) and the proportion of adjusted strata;
 - which can lead to **non-negligible cumulative changes** : the implicit quality adjustment for pupils with disability that increases the total growth of education volume by one percentage point between 2006 and 2023, from -0.5% to 0.5%
- Pending questions ..
 - Better calibration of elasticities ?
 - Other outcome measures ?
 - Other non market sectors ? Health $\implies$ Fouliard (2026)

Conclusion

- Integrating quality adjustments within an economically interpretable theoretical framework based on the concept of human capital leads to ..
 - modest changes (-0.056 point per year on average for PISA, +0.016 point per year on average for class size) : due to the size of elasticities (0.04 for class size) and the proportion of adjusted strata;
 - which can lead to **non-negligible cumulative changes** : the implicit quality adjustment for pupils with disability that increases the total growth of education volume by one percentage point between 2006 and 2023, from -0.5% to 0.5%
- Pending questions ..
 - Better calibration of elasticities ?
 - Other outcome measures ?
 - Other non market sectors ? Health $\implies$ Fouliard (2026)
 - Identifiable decomposition + link with output index $\implies$ Fouliard (2026)